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film according to the present invention exhibits more uniform stretchability than that of the laminate film disclosed in Japanese Patent Application Laying-Open No. 58-128821 (1983). The gas-barrier property of the laminate tubular film according to the present invention is of course excellent.

A VDC usable as the gas-barrier layer in a heat-shrinkable laminate tubular film according to the present invention comprises a copolymer of from 65 to 95% by weight of vinylidene chloride and from 5 to 35% by weight of at least one comonomer copolymerizable with vinylidene chloride. As the comonomer copolymerizable with vinylidene chloride, for instance, vinyl chloride, acrylonitrile and, C₁ to C₁₈-alkyl acrylates may be mentioned. Of these comonomers, vinyl chloride is generally used. The VDC may contain a small amount of plasticizer(s) and/or stabilizer(s) according to necessity. These additives, i.e., the plasticizers and stabilizers, used in the present invention have been known by the persons skilled in the art and represented by, for example, dioctyl adipate and epoxidized soy-bean oil.

As has been stated, it is necessary that the thickness of the gas-barrier layer of the VDC is not less than 6 μ m and is not more than 30%, preferably not more than 25% of the total thickness of the laminate tubular film according to the present invention. If below 6 μ m, the retention time thereof in the passage of the die becomes so large in extruding the VDC with the polyamide or the thermoplastic polyester in lamination that the VDC decomposes, thereby giving difficulty in co-extrusion.

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On the other hand, if it is over 30% of the total thickness of the laminate tubular film, the impact strength of the laminate tubular film at low temperatures is reduced.

As the polyolefin of the outer layers, high density polyethylene, middle density polyethylene, low density polyethylene, ionomers, a copolymer of ethylene and vinyl acetate, a copolymer of ethylene and an ester of acrylic acid, a copolymer of ethylene and propylene, polypropylene, a copolymer of ethylene and α -olefin (the so-called linear low density polyethylene, hereinafter referred to as LLDPE), a polybutene and mixture thereof may be mentioned.

The preferable embodiments of the outer layers from the viewpoint of stretchability of the layer(s) are as follows.

i) At least one of outer layers is EVA of a crystal melting point of from 80 to 103°C.

ii) One of the outer layers is EVA of a crystal melting point of 80 to 103°C, and the other of the outer layers is LLDPE of a crystal melting point of from 110 to 130°C.

iii) One of the outer layers is EVA of a crystal melting point of 80 to 103°C, and the other of the outer layers is a mixture of not more than 40% by weight of the LLDPE of a crystal melting point of 110 to 130°C and not less than 60% by weight of the EVA of a crystal melting point of 80 to 103°C.

iv) Both the outer layers are the mixture of not more than 40% by weight of LLDPE of a crystal melting point of 110 to 130°C and not less than 60% by weight of the EVA of a crystal melting point of 80 to 103°C.

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Of the four embodiments, i), ii) and iii) are preferable, particularly i) is more preferable, from the viewpoint of transparency of the thus prepared layer(s).

In addition, the total thickness of the layer(s) of the polyolefin is preferably in a range of from 40 to 92% of the total thickness of the heat-shrinkable laminate tubular film according to the present invention.

The use of at least one polyamide or thermoplastic polyester layer as the intermediate layer(s) is the characteristic feature of the heat-shrinkable laminate film according to the present invention, and by having the layer(s) of polyamide or thermoplastic polyester of an adequate rigidity and a favorable stretchability as intermediate layer, the stretchability and the rigidity of the laminate film comprising a VDC layer and the polyolefin layer(s) have been improved.

The laminate film disposed with two polyamide or thermoplastic polyester layers as intermediate layers between two outer layers of polyolefin and a core layer of VDC with adhesive layers is preferable.

As the polyamide, a polymer having a crystal melting point of not more than 240°C, preferably of 220°C is used and for instance, Nylon 6-66 (copolymer consisting of Nylon 6 and Nylon 66), Nylon 610 (polyhexamethylene sebacamide), Nylon 612 (a condensate of hexamethylenediamine and 1,10-decanedicarboxylic acid), Nylon 11 (a condensate of 11-aminoundecanoic acid), Nylon 12 (a ring-open polymerizate of laurolactum) and Nylon 6 (polycapramide) may be exemplified.

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As the thermoplastic polyester, a polymer having a crystal melting point of not more than 240°C, preferably not more than 220°C or showing no crystal melting point is used and the thermoplastic polyester comprises the acid moiety selected from an aromatic dibasic acid and an aliphatic dibasic acid and the glycol moiety selected from aliphatic glycol, cycloaliphatic glycol and aromatic glycol. As such an esters, for instance, Vylon (made by TOYOBO Co., Ltd.), Hytel (made by Goodyear Co., Ltd.) and PET-G (made by Eastman Kodak Co., Ltd.) may be exemplified.

For reference, the "crystal melting point" used in the present invention is the maximum temperature on a melting curve obtained by the determination on a specimen in an amount of 8 mg while using a differential scanning calorimeter (made by Perkin-Elmer Co., Model IB) at a rate of raising the temperature of 8°C/min.

In the case where the crystal melting point of the polyamide or the thermoplastic polyester is over 240°C, it is necessary to raise the extruding temperature, thereby the coextrusion of the polyamide or the thermoplastic polyester with VDC becomes difficult.

In the case where the heat-shrinkable laminate tubular film according to the present invention contains not less than two intermediate layers of the polyamide or the thermoplastic polyester, the two layers may be the same as each other or different from each other. It is necessary that the thickness of such layer is from 5 to 40%, more preferably

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from 5 to 20% of the total thickness of the laminate tubular film according to the present invention. When the number of such layers is not less than 2, the total thickness of such layers is from 5 to 40% of the total thickness of the laminate tubular film according to the present invention. On the other hand, where the thickness of such layer(s) is below 5% of the total thickness of the laminate tubular film according to the present invention, such layer(s) cannot contribute to the rigidity of the laminate tubular film, and in the case of over 40%, coextrusion with the VDC is difficult. From the viewpoint of co-extrudability with the VDC, the thickness of such layer(s) is more preferably not more than 20% of the total thickness of the laminate tubular film according to the present invention.

As the adhesive material forming the adhesive layer, EVA containing from 13 to 28% by weight of vinyl acetate units, a copolymer of ethylene and an ester of acrylic acid containing from 13 to 28% by weight of the ester of acrylic acid, a modified copolymer of ethylene and an ester of acrylic acid with an unsaturated carboxylic acid and a material obtained by further modifying the thus modified copolymer with a metal may be exemplified. Of the above adhesives, modified copolymer of ethylene and an ester of acrylic acid with the unsaturated carboxylic acid, and the material obtained by further modifying the thus modified copolymer of ethylene and an acrylic ester, with a metal are more preferable.

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Any one of the above-mentioned adhesive layer is disposed between the polyolefin layer and the VDC layer, between the VDC layer and the polyamide or the thermoplastic polyester layer, and between the polyolefin and the polyamide or thermoplastic polyester layer.

The thickness of an adhesive layer is preferably from 0.5 to 3 μm , and the total thickness of the adhesive layers is preferably from 20 to 120 μm .

In the preparation of the heat-shrinkable laminate tubular film, a plurality of resins each of which constructs a layer of the object laminate tubular film are respectively co-extruded from a common annular die connected to a plurality of extruders corresponding to a plurality of resins, thereby being extruded from the die as a laminate tubular film.

An assembling part of an example of such an annular die is schematically shown in Fig. 1 in which 7 is a passage of the assembled flow of the molten resins and the respective passages of the molten polyolefin, the molten VDC, the molten polyamide or the molten thermoplastic polyester, the molten polyolefin and the molten adhesive agent are shown by 1, 2, 4, 6 and 8. As shown in Fig. 1, it is preferable to provide the respective adiabatic spaces 3 and 5 on both sides of the passage for molten polyamide or molten thermoplastic polyester. By the thus provided adiabatic spaces, even in the case where the thermoplastic polyester is extruded at a high temperature, since the direct heat transfer to the VDC layer therefrom can be prevented, the VDC which is relatively apt

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to be decomposed can be coextruded with the thermoplastic polyester or the polyamide. In the case of preparing a laminate flat film by using a T-die, the both end parts of the layer of the VDC coextruded with the polyamide layer or the thermoplastic polyester layer are apt to be decomposed and accordingly, such an operation is not favorable.

Although the order of lamination of the layers is optional as far as both of the outer layers are a polyolefin, the arrangement of the layers in the laminate tubular film is preferably in the following order from the outer layer to the inner layer:

polyolefin layer/adhesive agent layer/VDC layer/
adhesive resin layer/polyamide layer or the thermoplastic resin
layer/adhesive resin layer/polyolefin layer.

The thus extruded laminate tubular film is stretched biaxially following the conventional biaxial inflation method to form the heat-shrinkable laminate tubular film according to the present invention.

Since the thus prepared, heat-shrinkable laminate tubular film of the present invention shows gas-barrier property and an adequate rigidity, it is suitably used in packaging particularly foodstuffs.

The present invention will be explained more in detail while referring to the following non-limitative examples.

EXAMPLES 1 TO 5 AND COMPARATIVE EXAMPLES 1 TO 3:

The VDC, the adhesive agent, the polyamide, the

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thermoplastic polyester and the polyolefin respectively shown in Table 1 were extruded from a plurality of extruders, respectively, and the thus extruded, molten resins were supplied, particularly in Examples 1 to 5, to the annular co-extruding die provided with the adiabatic spaces (3 and 5) shown in Fig. 1, thereby extruding the thus supplied molten resins as a laminate tubular film. The thus prepared laminate tubular film was cooled in a quenching bath at 15 to 25°C to form a laminate tubular film of 120mm in folded width and 540µm in thickness. A small amount of soy-bean oil had been introduced into the inside space of the tubular film for the prevention of self-adherence of the inner layer when folded.

Then, the laminate tubular film was transferred through a hot water bath at a temperature shown in Table 3 at a transferring speed of 20 m/min and heated for about 12 sec while being pinched by the first pair of nip-rolls rotating at a speed of 20 m/min. Thereafter, the thus heated tubular film was taken out from the hot water bath and was stretched between the first pair of nip-rolls rotating at a speed of 20 m/min and the second pair of nip-rolls rotating at a speed of 60 m/min, into the longitudinal direction at a stretched ratio of 3 (i.e. $60/20=3$) while simultaneously being stretched to the diametrical direction 3 times by air supplied into the inside space of the tubular film. The thus obtained, biaxially stretched laminate film was 350mm in folded width and about 60 micrometer in thickness.

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Table 1
Properties of Resins used

Resin	Density	Melt index (g/10min)	Crystal melting point (°C)	Remarks
VDC ¹⁾	-	-	-	
Polyamide	1.14	-	215	Nylon 6-66 made by TORAY Co., Ltd.
Thermoplastic polyester	1.267	-	not shown	PET-G, made by Eastman Kodak Co., Ltd.
LLOPE	0.922	2.5	122	Made by MITSUBISHI Co., Ltd.
EVA-1	0.933	1.1	96	Content of vinyl acetate units of 5.5% by weight
EVA-2	0.93	1.5	91	Content of vinyl acetate units of 10% by weight
EVA-3	0.94	0.6	82	Content of vinyl acetate units of 15% by weight
N-polymer (as adhesive) ²⁾	0.95	6	-	

Notes

1): A resinous mixture of 100 parts by weight of a copolymer of vinylidene chloride (70% by weight) and vinyl chloride (30% by weight) and 1 part by weight of an epoxidized soy-bean oil.

2): A modified copolymer of ethylene and an ester of acrylic acid, obtained by modifying the copolymer of ethylene and an ester of acrylic acid with an unsaturated carboxylic acid, made by Nippon Petrochemical Co., Ltd.

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Table 2

Item	Method
Shrinkage in hot water	After immersing a specimen (10 cm square) of each of the laminate films at a relaxed state thereof in hot water at 90°C for one min, the percentage of the length to the original length and the percentage of the width to the original width are shown, respectively as the averaged values of the test data on 20 specimens.
Gas-barrier property	The volume of gaseous oxygen (ml/m ² of the film·24 hours·atm) permeated through a specimen of each of the laminate films at 30°C and relative humidity of 100%, respectively as the averaged values of the test data on 3 specimen.

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Table 3
Layer Construction of Tubular Film and Temperature of Hot Water Bath

Examples and Comparative Example	Layer Construction							Temperature of Hot Water Bath (°C)
	1st layer (µm)	2nd layer (µm)	3rd layer (µm)	4th layer (µm)	5th layer (µm)	6th layer (µm)	7th layer (µm)	
Ex. 1	EVA-3 (12)	N-polymer (1)	VDC (8)	N-polymer (1)	Polyamide (6)	N-polymer (1)	EVA-3 (31)	85
Ex. 2	EVA-3 (12)	N-polymer (1)	VDC (8)	N-polymer (1)	PET-G (6)	N-polymer (1)	EVA-3 (31)	87
Ex. 3	LLDPE/EVA-1 ¹ (12)	N-polymer (1)	VDC (10)	N-polymer (1)	Polyamide (6)	N-polymer (1)	LLDPE/EVA-2 ² (29)	94
Ex. 4	LLDPE (9)	N-polymer (1)	VDC (8)	N-polymer (1)	PET-G (6)	N-polymer (1)	EVA-2 (34)	95
Ex. 5	LLDPE/EVA-1 ¹ (12)	N-polymer (1)	VDC (10)	N-polymer (1)	Polyamide (4)	N-polymer (1)	EVA-1 (31)	93
Comparat. Ex. 1	EVA-3 (15)	N-polymer (1)	VDC (8)	N-polymer (1)	EVA-3 (6)	N-polymer (1)	EVA-3 (28)	89
Comparat. Ex. 2	EVA-3 (12)	N-polymer (1)	VDC (4)	N-polymer (1)	Polyamide (15)	N-polymer (1)	EVA-3 (26)	-
Comparat. Ex. 3	LLDPE/EVA-1 ¹ (7)	N-polymer (1)	VDC (8)	N-polymer (1)	PET-G (27)	N-polymer (1)	LLDPE/EVA-2 ² (15)	98

Notes: *1: A mixture of 30 parts by weight of LLDPE and 70 parts by weight of EVA-1

*2: A mixture of 30 parts by weight of LLDPE and 70 parts by weight of EVA-2.

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Table 3-2: Physical Properties of Tubular Film

Example or Comparative Example	Stretch- ability	Rigidity	Rate of heat- shrinkage (longitudinal/ transversal)	Gas-barrier property	Coextrudability of tubular film
Example 1	A	A	51 / 53	58	A
Example 2	A	A	55 / 56	59	A
Example 3	A	A	43 / 45	50	A
Example 4	A	A	44 / 46	59	A
Example 5	A	A	45 / 47	50...	A
Comparative Example 1	B	C	50 / 53	60	A
Comparative Example 2	-	-	-	-	C
Comparative Example 3	C	-	-	-	B

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(Notes)

1) Stretchability:

- A: Excellent, particularly excellently stretchable with unevenness of the thickness of the film of below 30%.
- B: Inferior, although stretchable, with unevenness of the thickness of the film of from 30 to 50%.
- C: Poor, although stretchable, without steadiness and with unevenness of the thickness of the film over 50%.

2) Rigidity:

- A: Excellent, defects in the packaging operation such as the elongation of the film due to the content scarcely occur,
- B: Inferior, defects in the packaging operation occur some times,
- C: Poor, defects in the packaging operation are apt to occur.

3) Coextrudability of the layers into a composite laminate tube:

- A: Coextrusion was possible continuously for more than 10 hours,
- B: The time of sufficient, continuous extrusion was below 10 hours,
- C: Coextrusion could be continued only less than one hour.

As are clearly seen in the results of Examples 1 to 5 shown in Table 3, the heat-shrinkable laminate tubular film according to the present invention is excellent in stretchability and adequate rigidity, thereby excellent in processability in the packaging operation. In addition, the

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combination of the resins for producing the film was excellent in coextrudability.

On the other hand, although the resin combination of Comparative Example 1 was excellent for coextruding, the rigidity of the film was poor resulting in the poor processability in the packaging operation due to the absence of the layer of the polyamide or the thermoplastic polyester.

Although the resin combination of Comparative Example 2 includes the polyamide for the inner layer, because of the too thin layer of the VDC, decomposition of the VDC occurred to inhibit the continuous operation of coextrusion. In Comparative Example 3, because of the too large thickness of the layer of the thermoplastic polyester, the coextrudability was poor to cause the decomposition of the VDC. In addition, the coextruded film was poor in stretchability. By the above-mentioned demerits, any favorable laminate film could not be obtained.

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CLAIMS:

1. A heat-shrinkable laminate tubular film comprising a gas-barrier layer of a copolymer of vinylidene chloride having a thickness of not less than 6µm and not more than 30% of the total thickness of the tubular film, outer layers of a polyolefin, at least one intermediate layer of a polyamide or a thermoplastic polyester having a crystal melting point of not more than 240°C and a thickness of 5 to 40% of the total thickness of the tubular film, and adhesive layers disposed between any of the above layers.

2. A heat-shrinkable laminate tubular film according to claim 1, wherein at least one of the outer layers is a copolymer of ethylene and vinyl acetate of a crystal melting point in a range of from 80 to 103°C.

3. A heat-shrinkable laminate tubular film according to claim 2, wherein one of the outer layers is a linear low-density polyethylene of a crystal melting point in a range of from 110 to 130°C or a mixture of not more than 40% by weight of the linear low-density polyethylene and not less than 60% by weight of a copolymer of ethylene and vinyl acetate of a crystal melting point in a range of from 80 to 103°C.

4. A heat-shrinkable laminate tubular film according to claim 1, wherein each of the outer layers is a mixture of not more than 40% by weight of a linear low-density polyethylene of a crystal melting point in a range of from 110 to 130°C and not less than 60% by weight of a copolymer of ethylene and vinyl

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acetate of a crystal melting point in a range of from 80 to 103°C.

5. A heat-shrinkable laminate tubular film according to claim 1, wherein the total thickness of the heat-shrinkable laminate tubular film is in a range of from 20 to 120 micrometers,

the thickness of the gas-barrier layer is more than 6µm and not more than 25% of the total thickness of the heat-shrinkable laminate tubular film,

the thickness of the outer layer is in the range of 40 to 92% of the total thickness of the heat-shrinkable laminate tubular film,

the thickness of the intermediate layer(s) of a polyamide or a thermoplastic polyester is in the range of 5 to 20% of the total thickness of the heat-shrinkable laminate tubular film, and

the thickness of each of adhesive layers is 0.5 to 3.0µm.

6. Process for producing a heat-shrinkable laminate tubular film according to claim 1, comprising

feeding a copolymer of vinylidene chloride as a gas-barrier layer, a polyolefin as outer layers, a polyamide or a thermoplastic polyester as at least one intermediate layer and an adhesive material as adhesive layers to an annular die provided with passages for the gas-barrier layer, the outer layers, the intermediate layer(s) and the adhesive layers and

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with adiabatic spaces disposed on the both sides of the passage(s) of the intermediate layer(s), in a molten state, the end portions of the passages of the gas-barrier layer, the outer layers, the intermediate layer(s) and the adhesive layers emerging into a common outlet of the annular die.

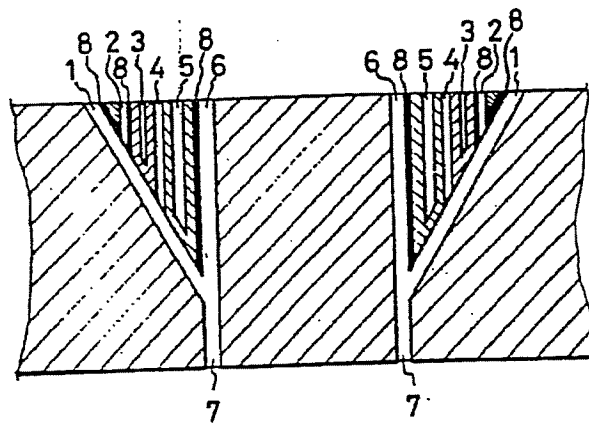
laminating and extruding the copolymer of vinylidene chloride, the polyolefin, the polyamide or the thermoplastic polyester and the adhesive material, thereby forming laminate tubular film at the outlet of the annular die,

cooling the resultant laminate tubular film by quenching, and

after heating the laminate tubular film, biaxially stretching the resultant laminate tubular film, thereby forming a heat-shrinkable laminate tubular film.

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Fig. 1



European Patent
Office

EUROPEAN SEARCH REPORT

0149321
Application number

EP 84 30 8302

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claims	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X	GB-A-1 591 424 (GRACE) * Page 2, lines 115-129; page 3, lines 24-33; page 4, lines 40-63, 79-120 *	1	B 65 D 75/00 B 32 B 27/08 B 65 D 65/40
A		2	
A	* Page 4, lines 46-85 *	5	
X	FR-A-2 211 339 (DOW CHEMICAL) * Claim 12; figures 1-3 *	6	
A	GB-A-1 422 358 (DOW CHEMICAL) * Page 3, example 1 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			B 32 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28-03-1985	Examiner VAN THIELEN J.B.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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